US011500330B2

(12) **United States Patent**
Sakurai et al.

(10) **Patent No.: US 11,500,330 B2**
(45) **Date of Patent: Nov. 15, 2022**

(54) **IMAGE FORMING APPARATUS HAVING DEVELOPING DEVICE WITH AIR SUCTION DEVICE**

(71) Applicant: **Konica Minolta, Inc.**, Tokyo (JP)

(72) Inventors: **Shota Sakurai**, Machida (JP); **Kei Yuasa**, Hino (JP); **Takenobu Kimura**, Hachioji (JP); **Tetsuya Ishikawa**, Sagamihara (JP)

(73) Assignee: **KONICA MINOLTA, INC.**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **17/503,767**

(22) Filed: **Oct. 18, 2021**

(65) **Prior Publication Data**

US 2022/0121151 A1 Apr. 21, 2022

(30) **Foreign Application Priority Data**

Oct. 19, 2020 (JP) JP2020-175061

(51) **Int. Cl.**
G03G 15/08 (2006.01)
G03G 21/00 (2006.01)
G03G 21/20 (2006.01)

(52) **U.S. Cl.**
CPC ***G03G 21/206*** (2013.01); ***G03G 15/0898*** (2013.01); *G03G 2221/1645* (2013.01)

(58) **Field of Classification Search**
CPC G03G 15/0844; G03G 21/206; G03G 2221/1645; G03G 15/0898
USPC 399/92, 98, 99, 264
See application file for complete search history.

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Primary Examiner — Robert B Beatty
(74) *Attorney, Agent, or Firm* — Squire Patton Boggs (US) LLP

(57) **ABSTRACT**

Provided is an image forming apparatus including an image carrier, an exposure device, a developing device that supplies a developer to form a toner image, and a hardware processor that controls the image carrier, the exposure device, and the developing device. The image forming apparatus further includes a fume prevention plate that covers a part of an internal space of the developing device where the developing roller is disposed and the developer is stored and that prevents the developer from scattering outside from the internal space, a suction duct, and an air suction device. One end of the suction duct is connected to the internal space and another end of the suction duct is connected to the air suction device. The fume prevention plate includes a movable portion. A position of the movable portion can be changed between a first position and a second position different from the first position.

19 Claims, 10 Drawing Sheets

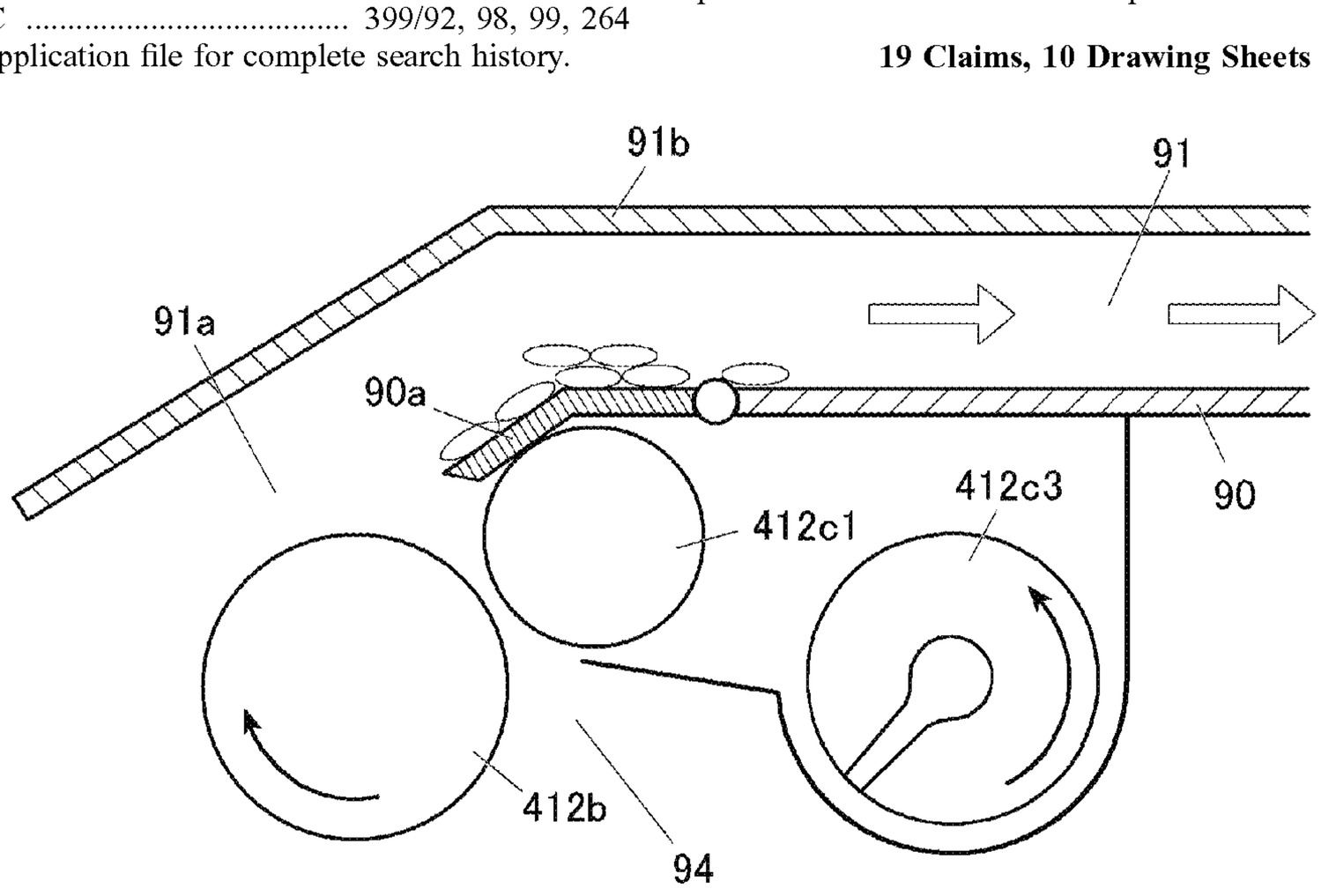

FIG. 1

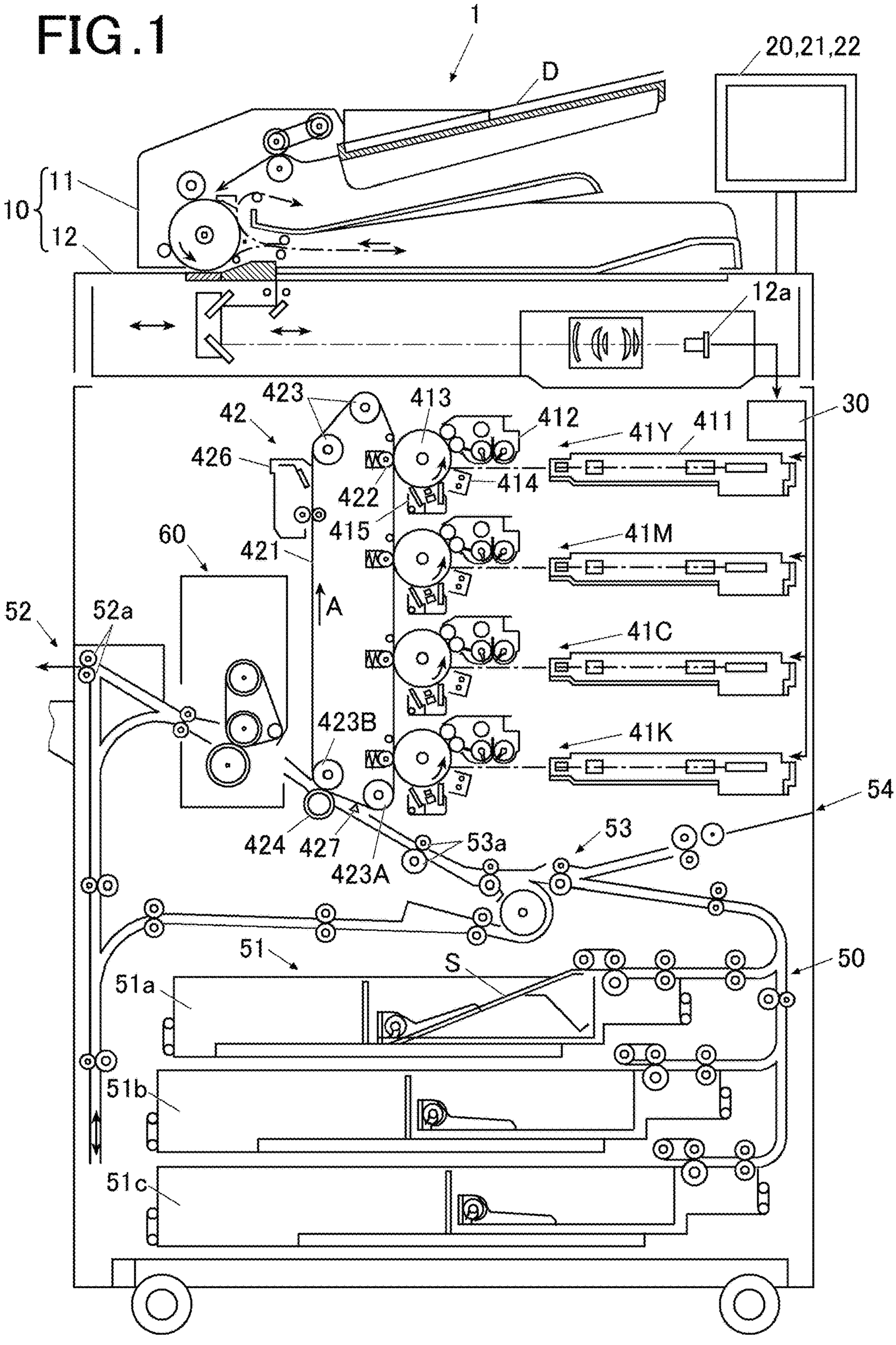
1
D
20,21,22
10
11
12
12a
423
42
413
412
41Y
411
30
426
422
414
415
60
421
41M
A
52
52a
41C
423B
41K
54
424
427
53a
53
423A
51
S
50
51a
51b
51c

FIG. 2

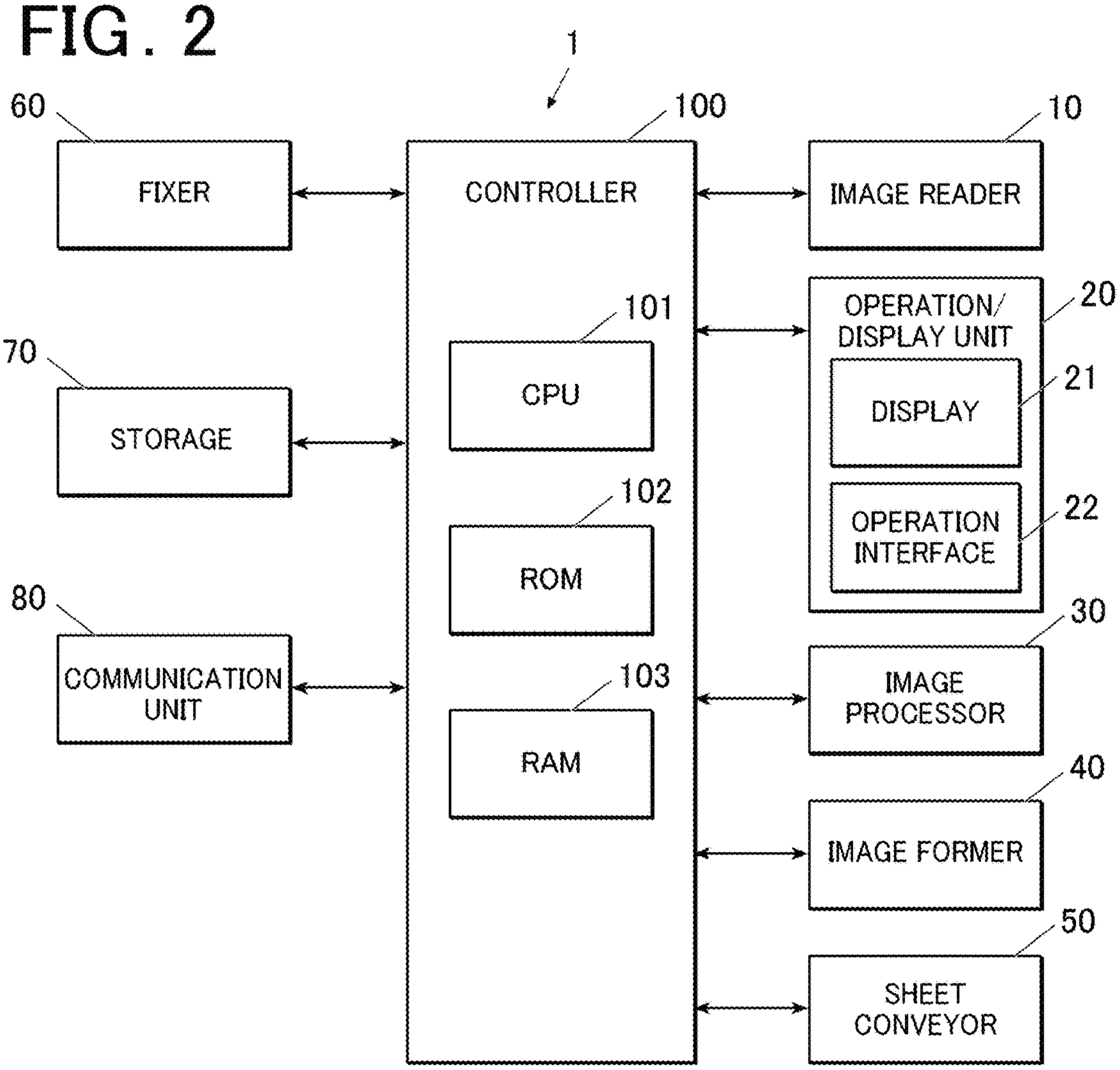
1
60
FIXER
100
CONTROLLER
10
IMAGE READER
101
CPU
70
STORAGE
20
OPERATION/
DISPLAY UNIT
21
DISPLAY
22
OPERATION
INTERFACE
102
ROM
80
COMMUNICATION
UNIT
103
RAM
30
IMAGE
PROCESSOR
40
IMAGE FORMER
50
SHEET
CONVEYOR

FIG. 3

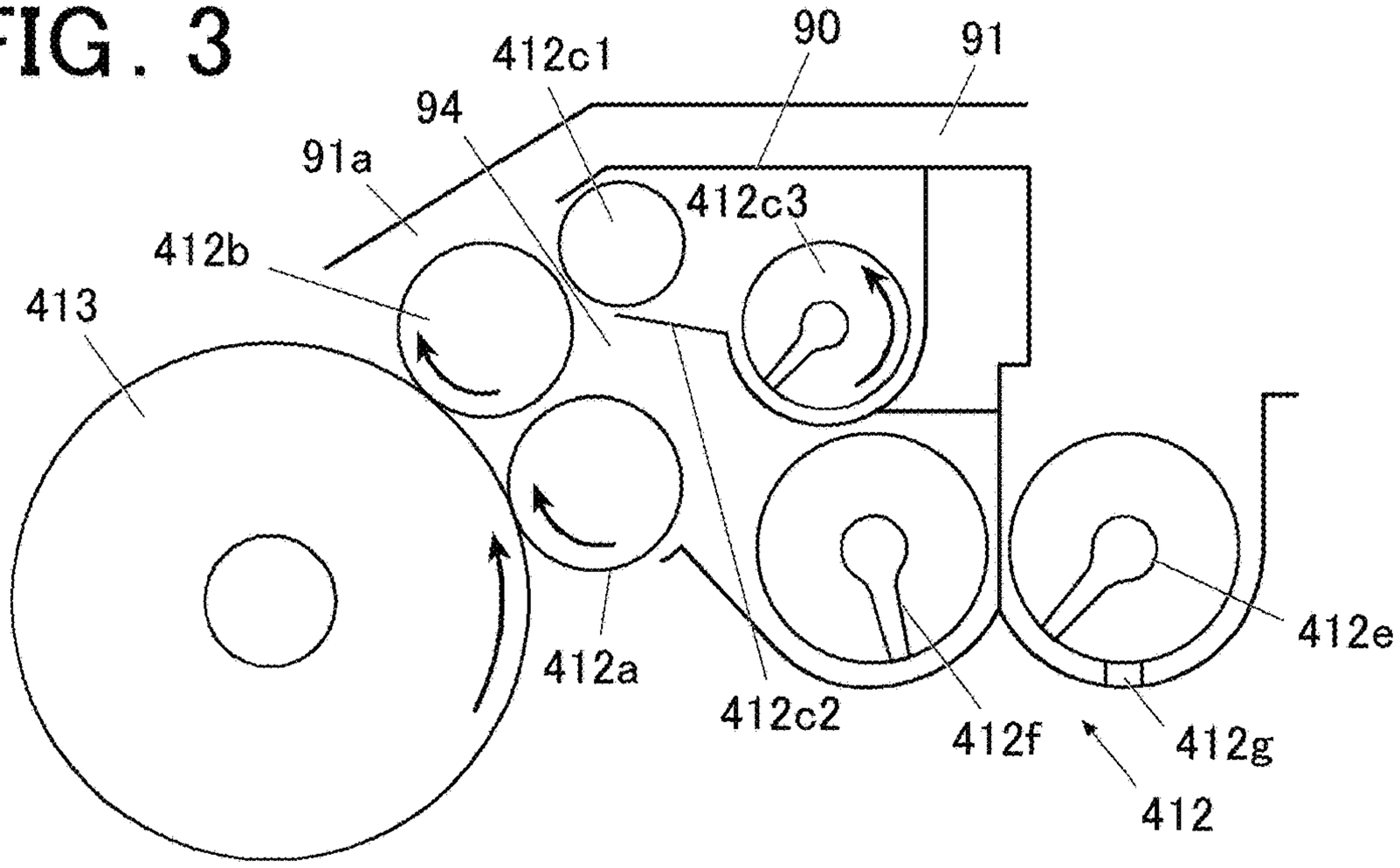
412c1
90
91
94
91a
412c3
412b
413
412a
412c2
412f
412g
412e
412

FIG. 4

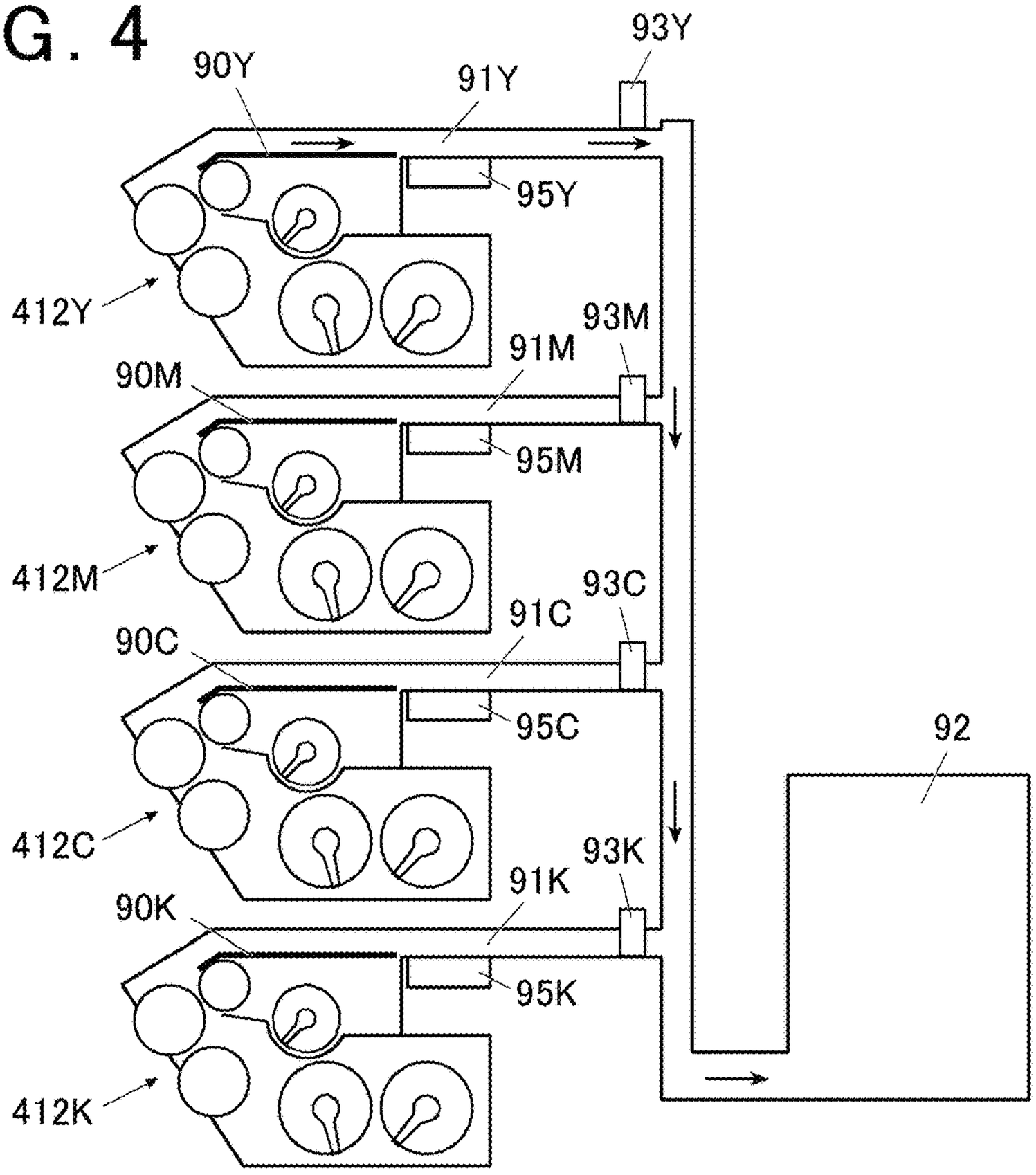
90Y
91Y
93Y
95Y
412Y
93M
91M
90M
95M
412M
93C
91C
90C
95C
92
412C
93K
91K
90K
95K
412K

FIG. 5

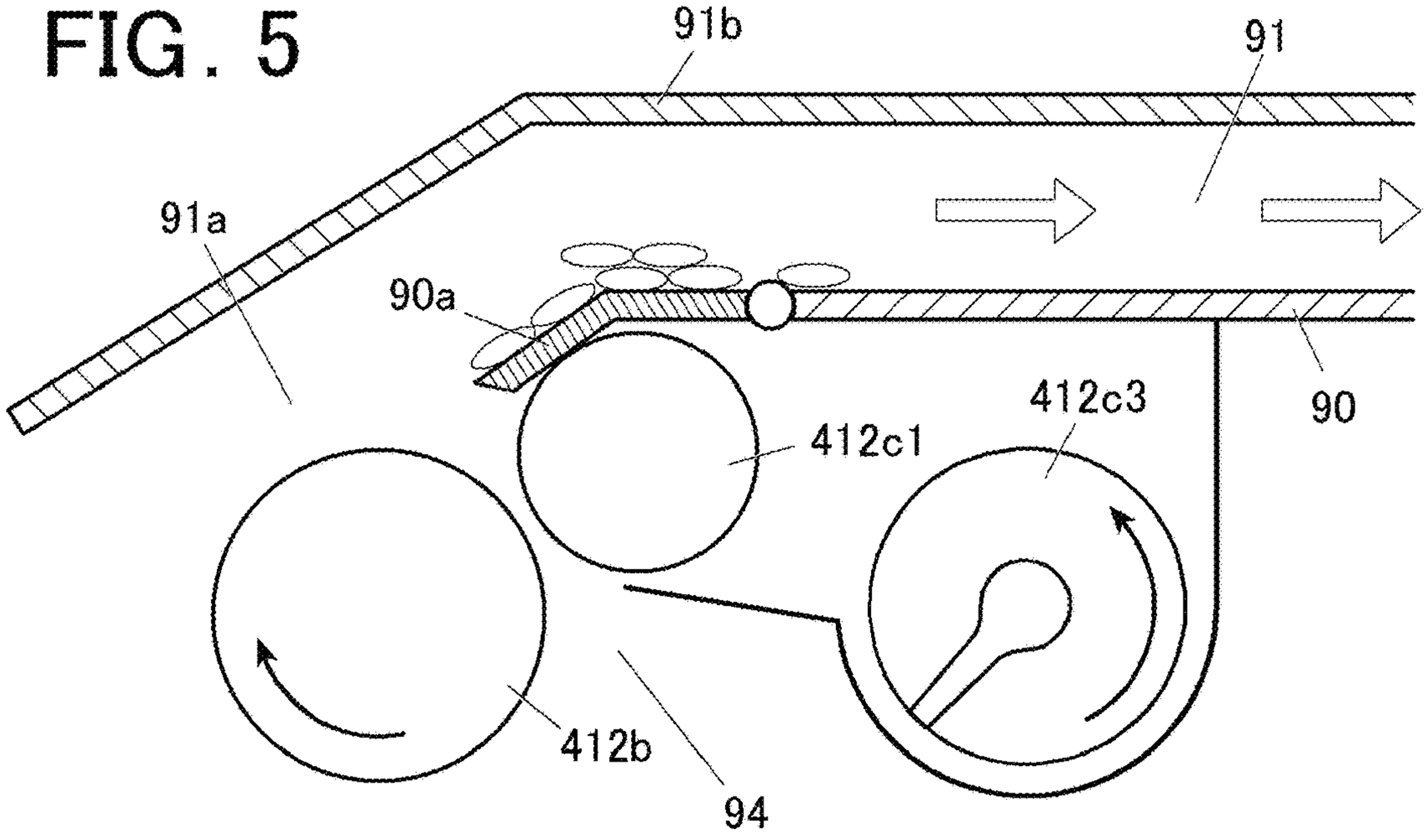
91b
91
91a
90a
412c3
412c1
90
412b
94

FIG. 6

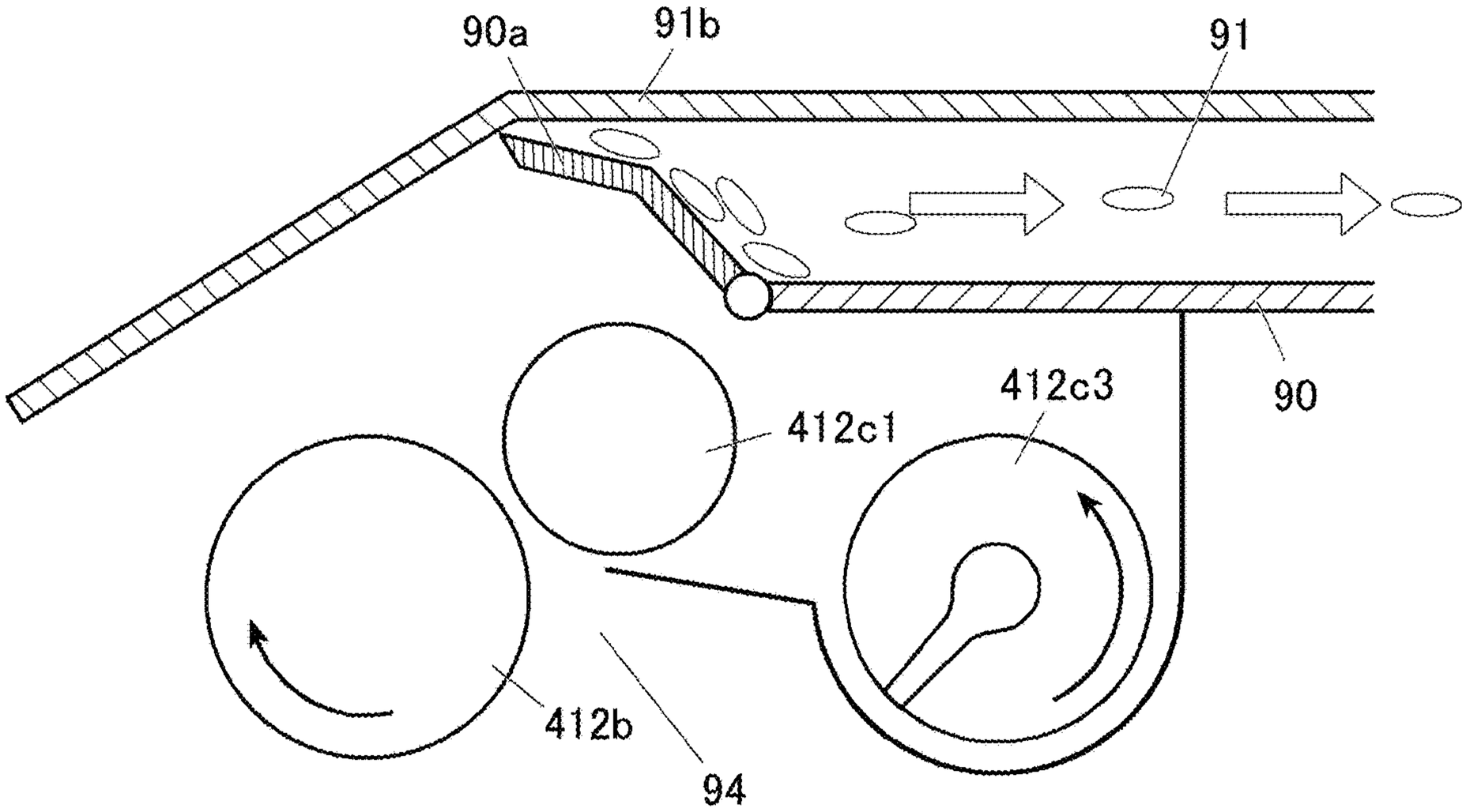

FIG. 7

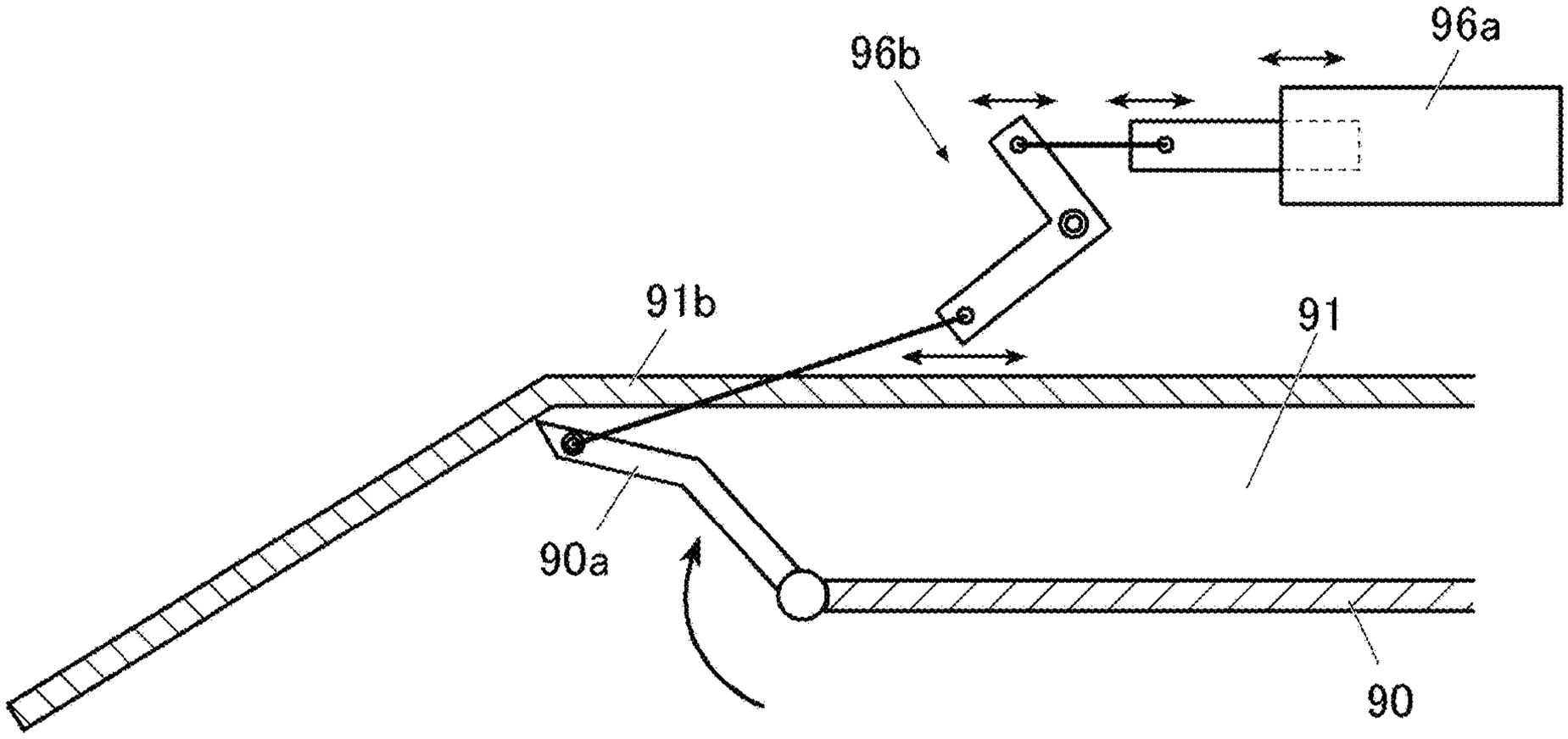

FIG. 8

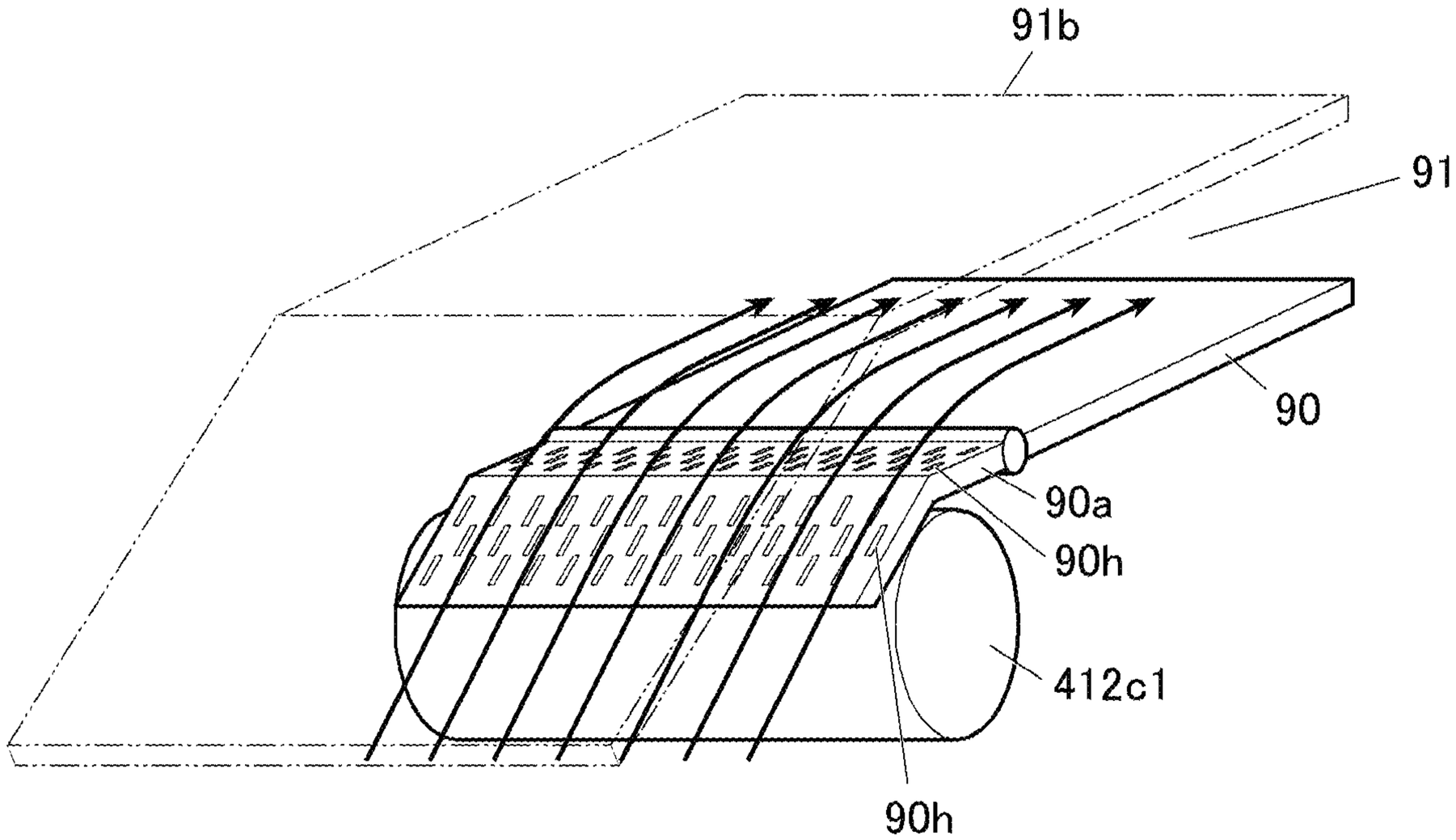

FIG. 9

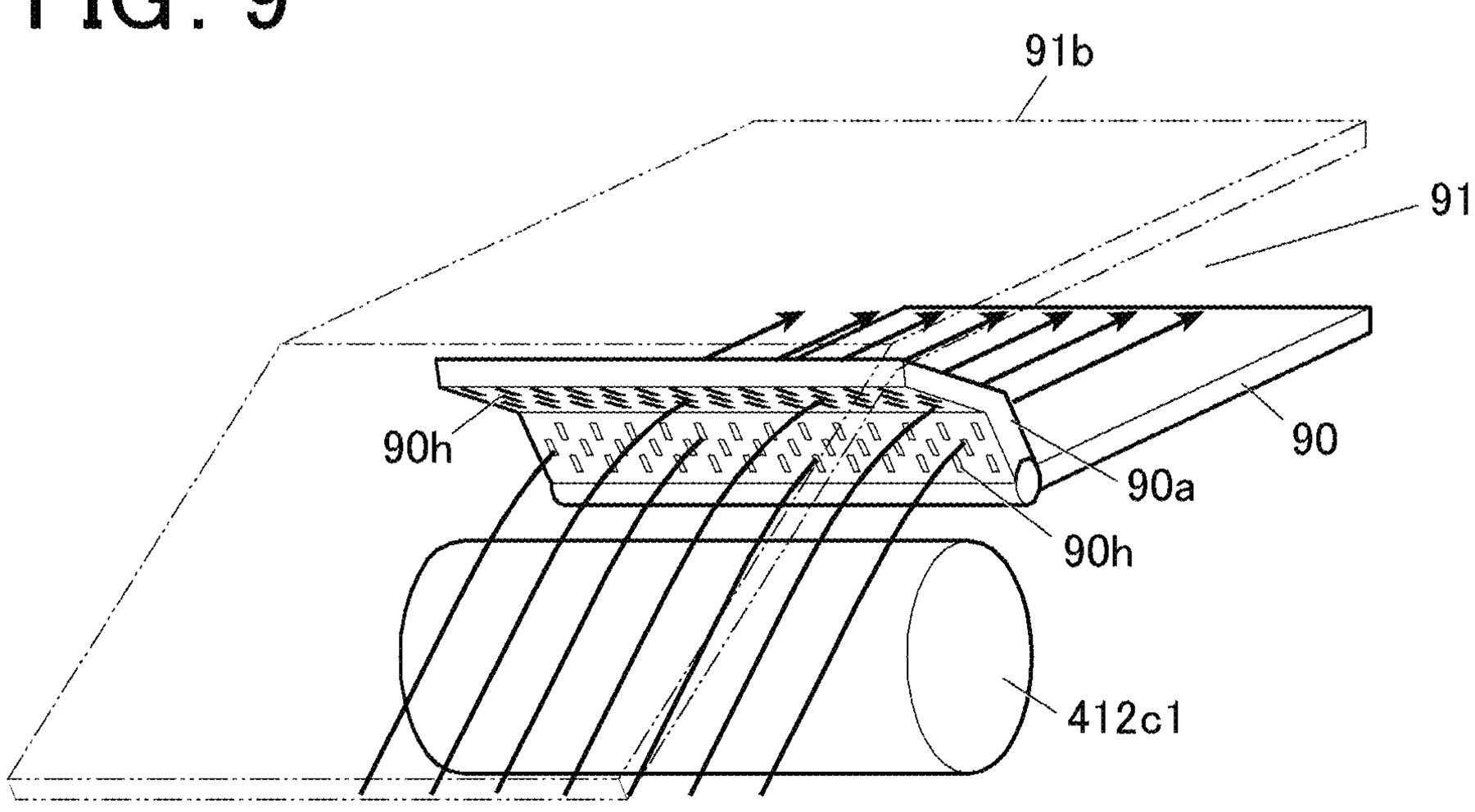

FIG. 10

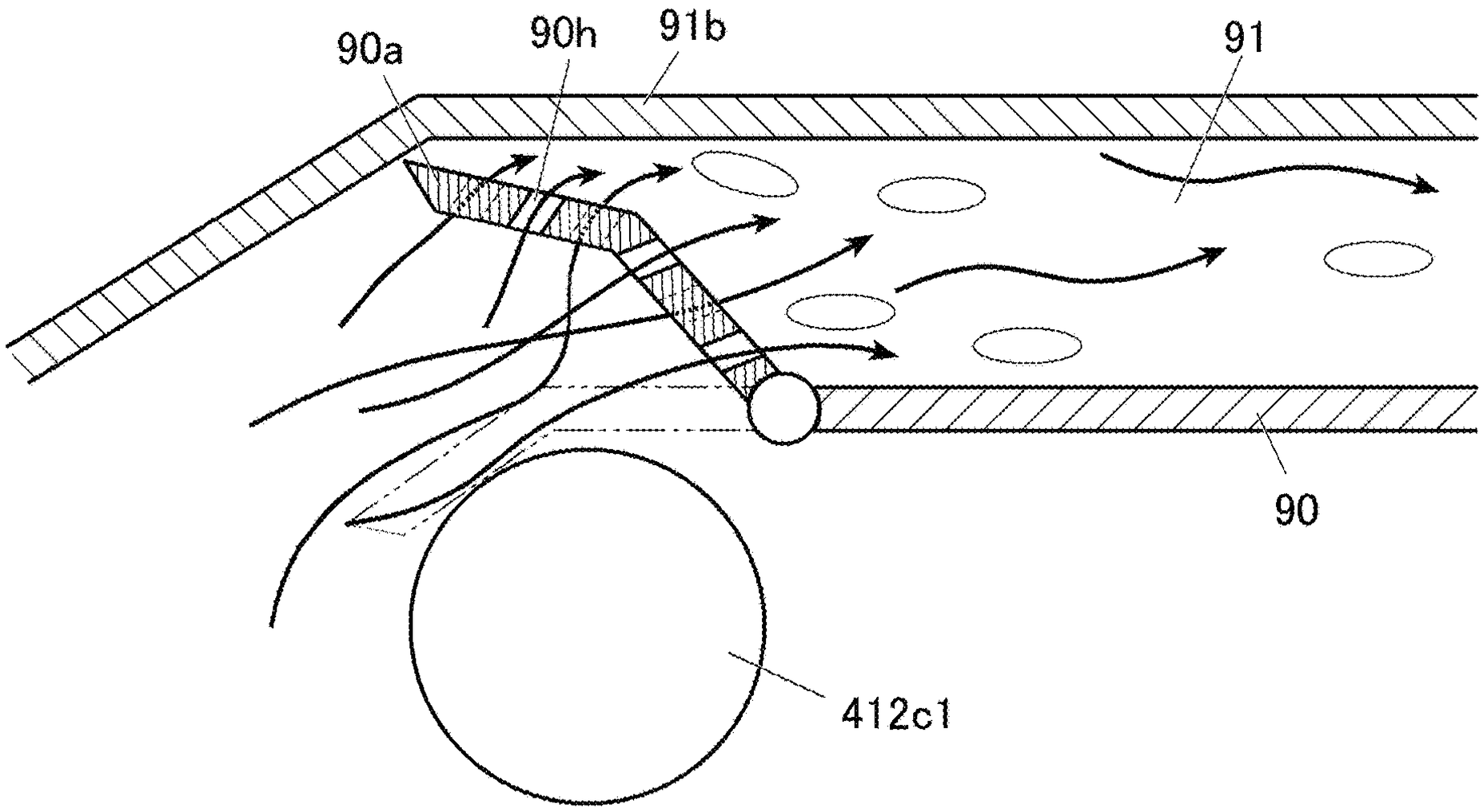

FIG. 11

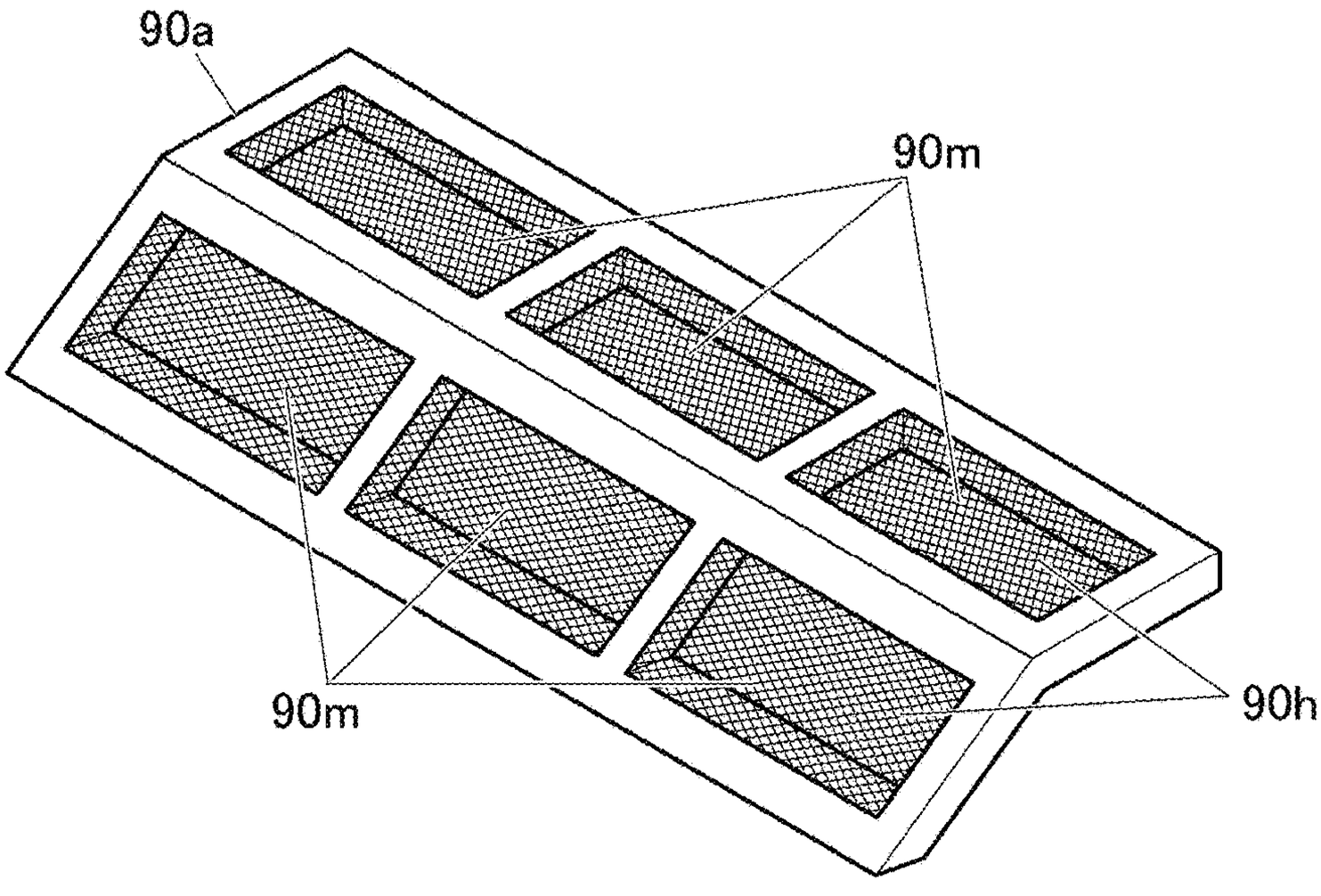

FIG. 12

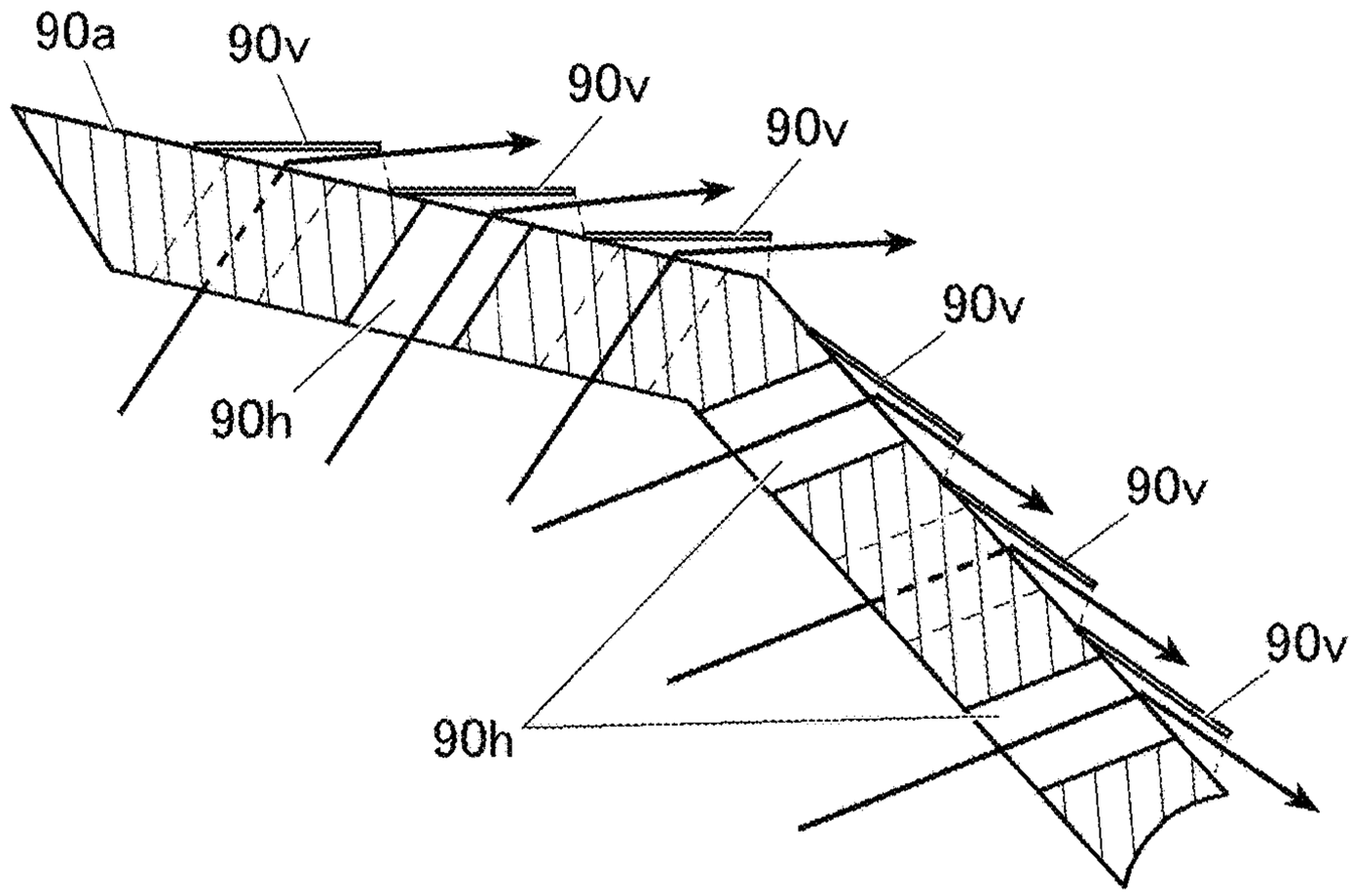
90a
90v
90v
90v
90v
90v
90h
90h

FIG. 13

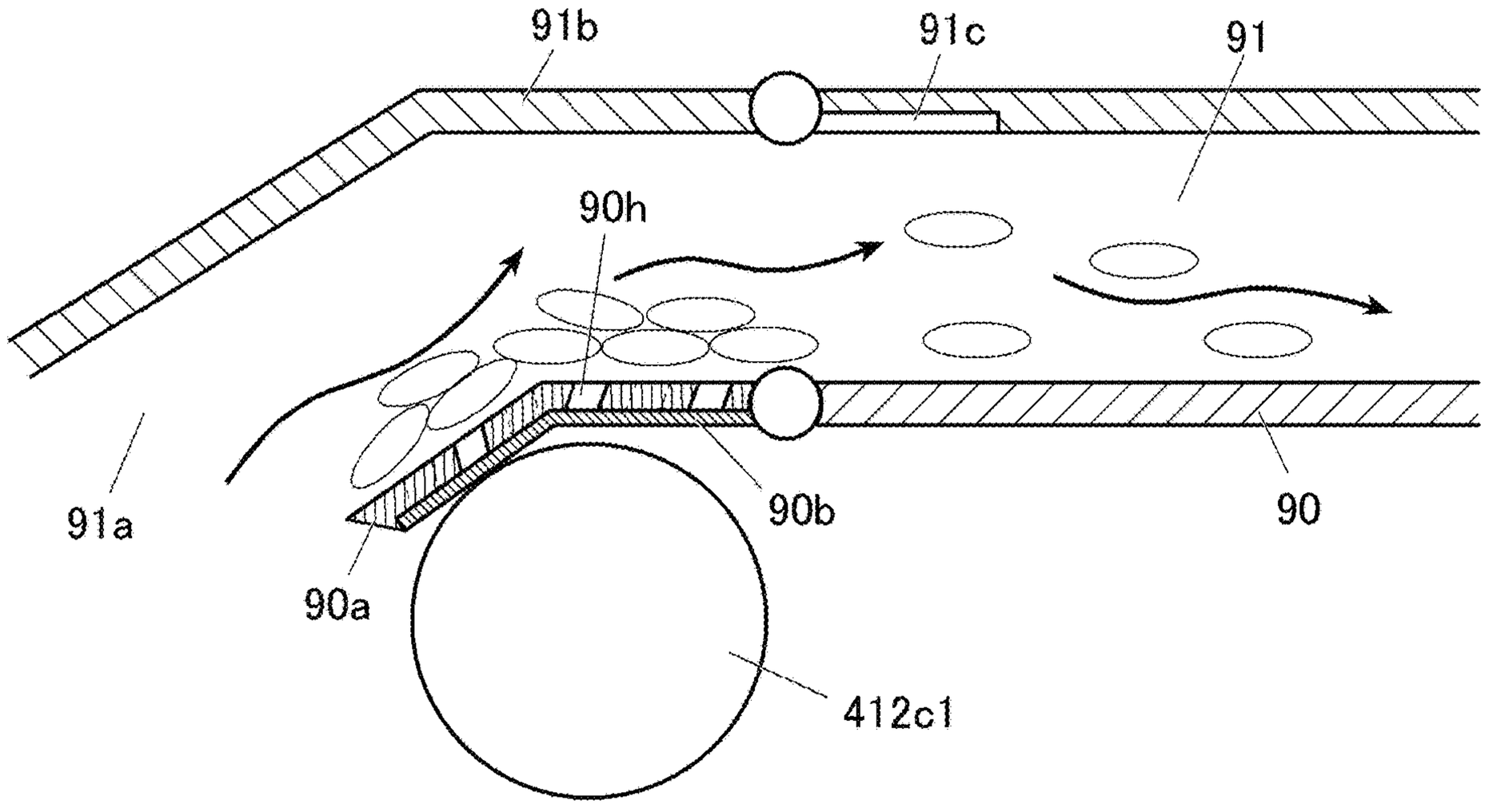
91b
91c
91
90h
91a
90b
90
90a
412c1

FIG. 14

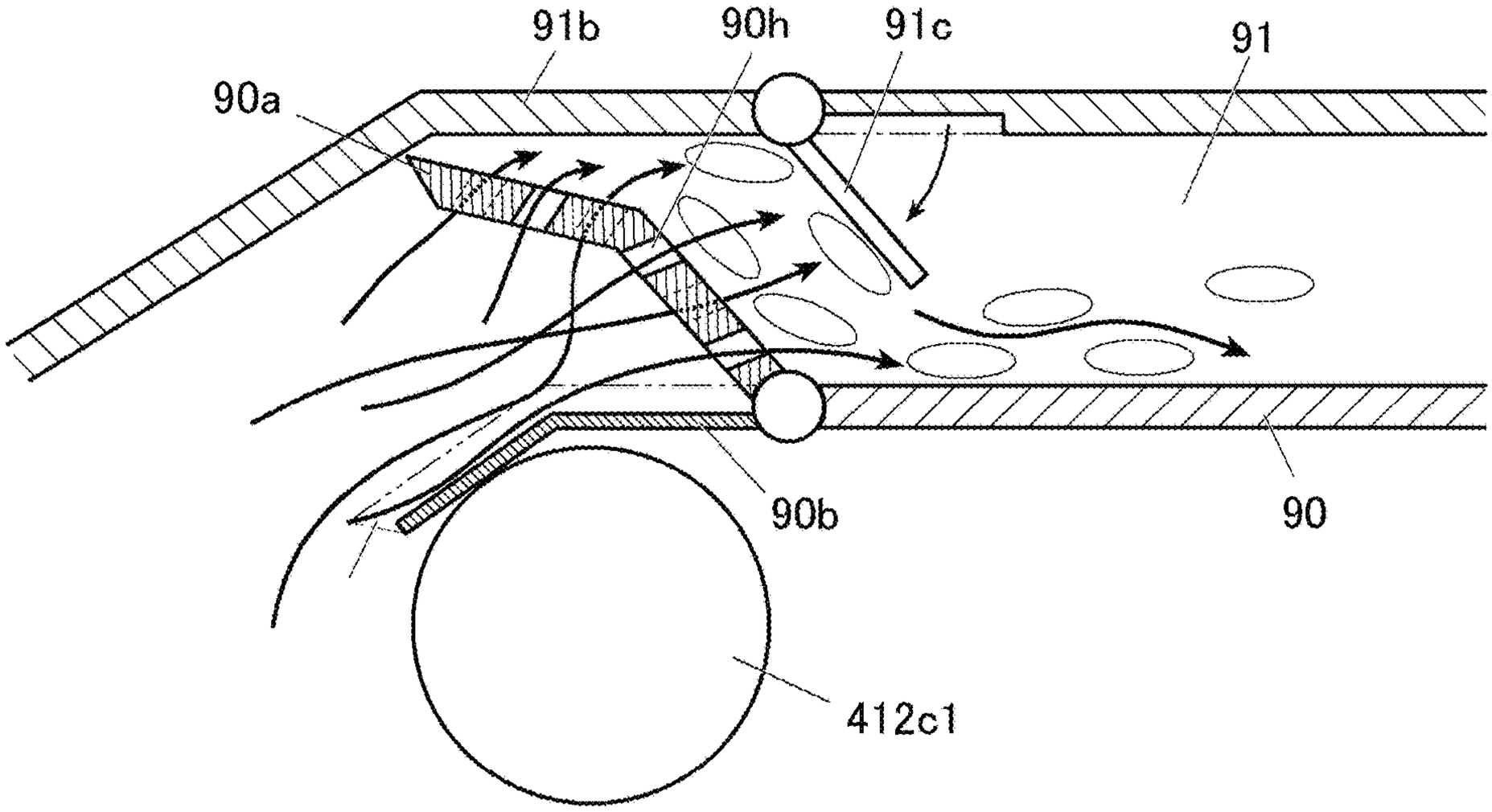
91b
90h
91c
91
90a
90b
90
412c1

FIG. 15

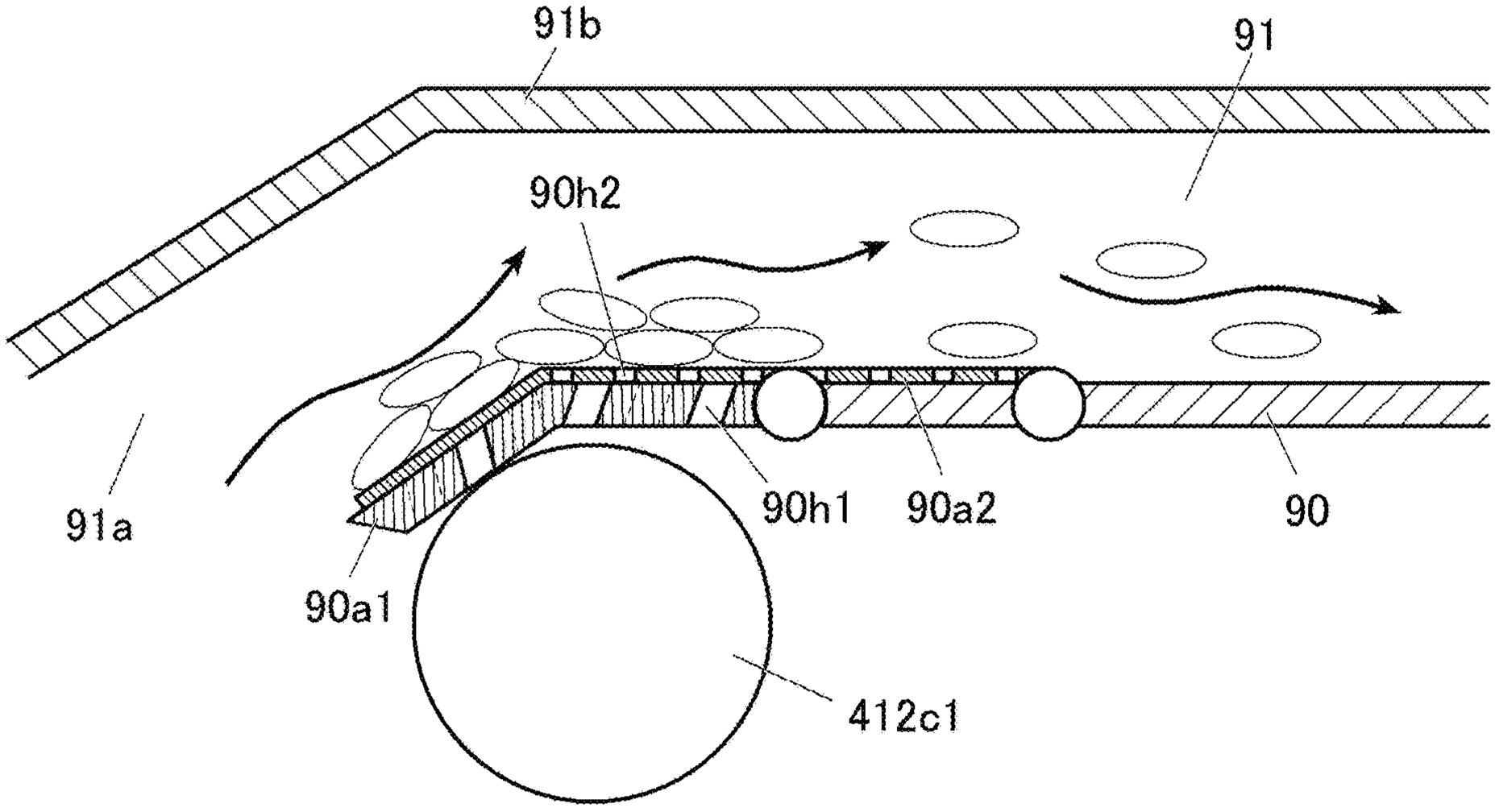
91b
91
90h2
91a
90h1
90a2
90
90a1
412c1

FIG. 16

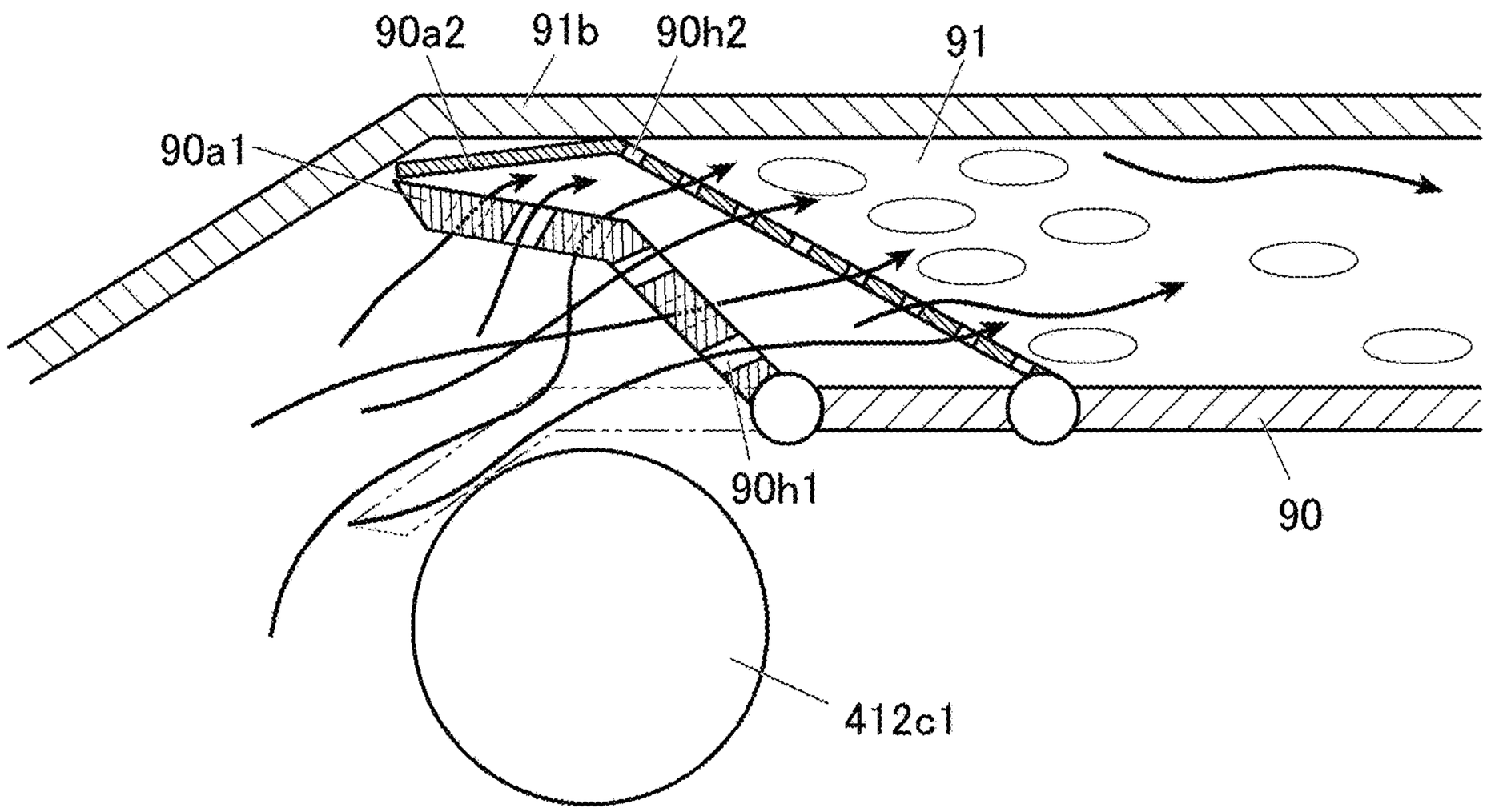

FIG. 17

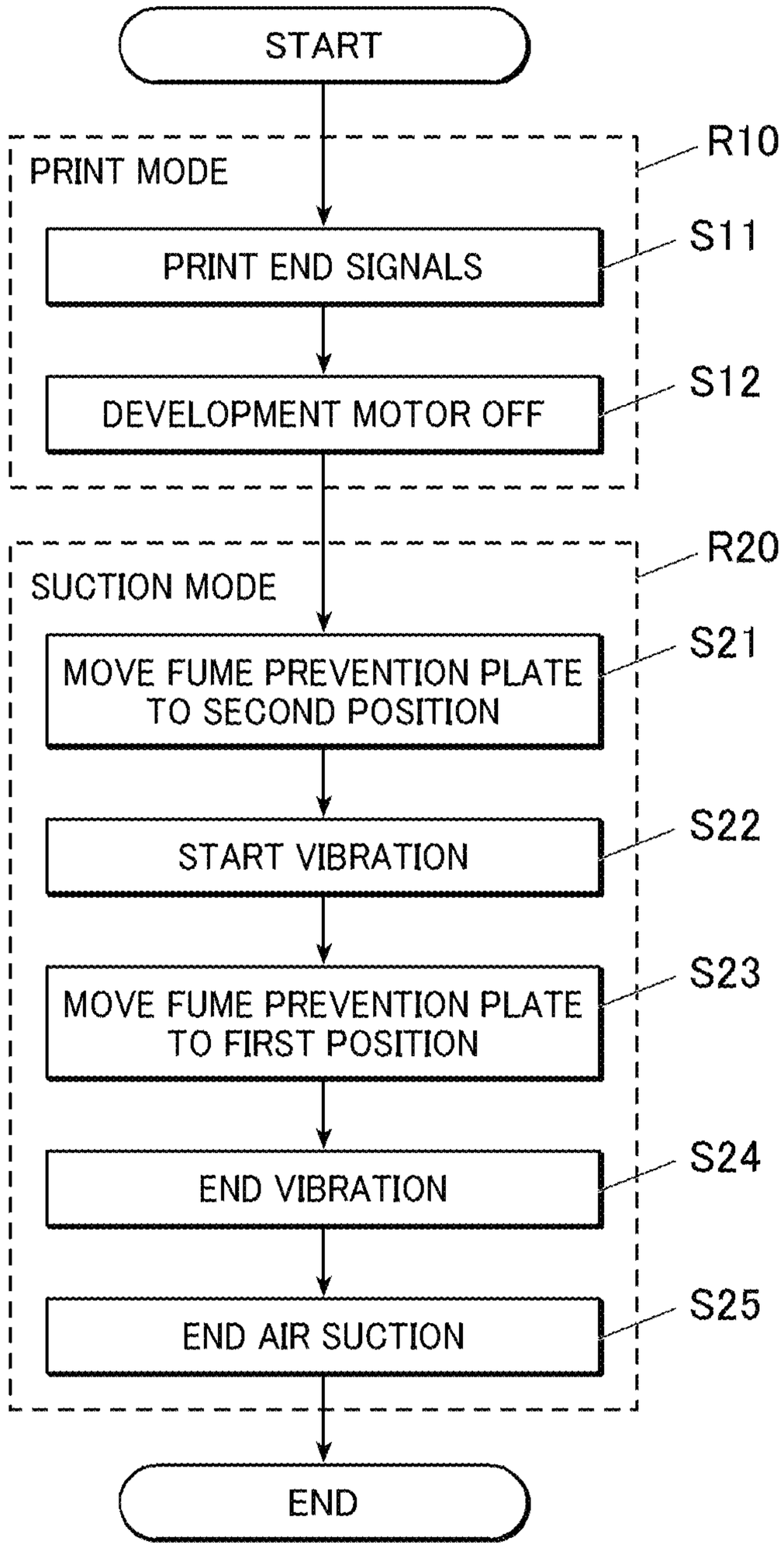
START
R10
PRINT MODE
PRINT END SIGNALS
S11
DEVELOPMENT MOTOR OFF
S12
R20
SUCTION MODE
MOVE FUME PREVENTION PLATE TO SECOND POSITION
S21
START VIBRATION
S22
MOVE FUME PREVENTION PLATE TO FIRST POSITION
S23
END VIBRATION
S24
END AIR SUCTION
S25
END

IMAGE FORMING APPARATUS HAVING DEVELOPING DEVICE WITH AIR SUCTION DEVICE

CROSS-REFERENCE TO RELATED APPLICATIONS

The entire disclosure of Japanese Patent Application No. 2020-175061 filed on Oct. 19, 2020 is incorporated herein by reference in its entirety.

BACKGROUND

Technological Field

The present invention relates to an image forming apparatus.

Description of the Related Art

Conventionally, there have been proposed techniques of sucking and removing toner scattered from a developing device in an electrophotographic image forming apparatus (JP 2015-060013 A, JP 2016-090879 A).

Scattered toner contaminates the inside of the image forming apparatus and causes errors such as a stained image. Thus, there have been known image forming apparatuses with a suction duct for sucking and removing scattered toner. It is thereby possible to suck and remove the toner scattered from the developing device through the suction duct, suppressing contamination in the image forming apparatus.

JP 2015-060013 A discloses a developer collection device that is provided with a suction inlet that can be opened and closed on the suction duct for scattered toner and that can suck the developer in the suction duct from the outside of the suction duct. There needs to be a service person who detaches the developing device and manually cleans the toner accumulated in the duct using a vacuum cleaner.

An image forming apparatus disclosed in JP 2016-090879 A includes a blowing means to blow air to a wall of a suction duct and removes toner attached to the wall of the suction duct by air blowing in view of a problem as follows: in a device that sucks and reduces toner scattered from a developing device with a suction duct, the scattered toner is accumulated on the wall of the suction duct (especially near the opening), and the accumulated toner falls off when some kind of vibration is applied to cause an image stain. As air is blown when image formation is not being performed, the attached toner is collected by a cleaning unit and does not get on an image even if it is attached to a photoreceptor or a developing roller.

SUMMARY

In an image forming apparatus configured to suck and reduce toner scattered from a developing device with a suction duct, developer (which may be toner only (the same shall apply hereinafter)) is accumulated on a fume prevention plate that prevents the developer from scattering outside from the internal space of the developing device, which may cause toner spill that affects the images.

Conventionally, developer is easily accumulated, and the accumulated developer is not easily removed, as the fume prevention plate is fixed.

In the image forming apparatus disclosed in JP 2016-090879 A, the accumulated developer is blown off and wound up. Thus, there is a necessity of cleaning and removing the developer. In addition, the image forming apparatus requires an air blowing mechanism separately, and it is necessary to maintain setting space of an air duct for blowing air individually from the suction duct.

The present invention has been conceived in view of the above-described problems in the prior art, and has an object of removing developer on a fume prevention plate of a developing device efficiently and effectively in an image forming apparatus configured to suck and reduce developer scattering from the developing device with a suction duct.

To achieve at least one of the abovementioned objects, an image forming apparatus reflecting one aspect of the present invention includes:

an image carrier;

an exposure device that draws an electrostatic latent image on the image carrier;

a developing device that supplies, using a developing roller facing the image carrier, a developer to the electrostatic latent image formed on the image carrier to form a toner image; and

a hardware processor that controls the image carrier, the exposure device, and the developing device,

wherein the image forming apparatus further includes:

a fume prevention plate that covers a part of an internal space of the developing device where the developing roller is disposed and the developer is stored and that prevents the developer from scattering outside from the internal space;

a suction duct; and

an air suction device,

wherein one end of the suction duct is connected to the internal space and another end of the suction duct is connected to the air suction device,

wherein the fume prevention plate includes a movable portion,

wherein a position of the movable portion can be changed between a first position and a second position different from the first position.

BRIEF DESCRIPTION OF THE DRAWINGS

The advantages and features provided by one or more embodiments of the invention will become more fully understood from the detailed description given hereinbelow and the appended drawings which are given by way of illustration only, and thus are not intended as a definition of the limits of the present invention, wherein:

FIG. **1** schematically shows an overall configuration of an image forming apparatus;

FIG. **2** is a block diagram showing a functional configuration of the image forming apparatus;

FIG. **3** is a cross-sectional view of a schematic configuration of a developing device;

FIG. **4** is a cross-sectional view of a structure of suction from developing devices of four colors;

FIG. **5** is a cross-sectional view of a structure of suction from a developing device;

FIG. **6** is a cross-sectional view of a structure of suction from a developing device;

FIG. **7** is a cross-sectional view of a structure of suction from a developing device;

FIG. **8** is a perspective view of a structure of suction from a developing device;

FIG. **9** is a perspective view of a structure of suction from a developing device;

FIG. **10** is a cross-sectional view of a structure of suction from a developing device;

FIG. **11** is a perspective view of a movable portion with a mesh structure;

FIG. **12** is a cross-sectional view of a movable portion with check valves;

FIG. **13** is a cross-sectional view of a structure of suction from a developing device;

FIG. **14** is a cross-sectional view of a structure of suction from a developing device;

FIG. **15** is a cross-sectional view of a structure of suction from a developing device;

FIG. **16** is a cross-sectional view of a structure of suction from a developing device; and

FIG. **17** is a flowchart showing control steps from a print mode to a suction mode.

DETAILED DESCRIPTION OF THE EMBODIMENTS

Hereinafter, an embodiment of the present invention is described with reference to the drawings. The following is an embodiment of the present invention and does not limit the present invention.

[Configuration of Image Forming Apparatus]

FIG. **1** schematically shows an overall configuration of an image forming apparatus **1** in this embodiment. FIG. **2** is a block diagram showing a main functional configuration of the image forming apparatus **1** in this embodiment.

The image forming apparatus **1** shown in FIGS. **1**, **2** is an electrophotographic color image forming apparatus using an intermediate transfer system. In the image forming apparatus **1**, toner images formed with colors of yellow (Y), magenta (M), cyan (C), and black (K) on photoconductive drums **413** are transferred onto an intermediate transfer belt **421** (first transfer) so as to be superposed on one another, and the toner image of four colors is transferred onto a sheet of paper (second transfer). An image is thereby formed.

The image forming apparatus **1** employs the tandem method in which the photoconductive drums for the four colors of Y, M, C, and K are disposed in series in the running direction of the intermediate transfer belt **421** and the toner images of the respective colors are sequentially transferred onto the intermediate transfer belt **421**.

As shown in FIG. **2**, the image forming apparatus **1** includes an image reader **10**, an operation/display unit **20**, an image processor **30**, an image former **40**, a sheet conveyer **50**, a fixer **60**, a storage **70**, a communication unit **80**, and a controller **100** (hardware processor).

The controller **100** includes a central processing unit (CPU) **101**, a read only memory (ROM) **102**, and a random access memory (RAM) **103**. The CPU **101** reads out the program corresponding to the processing from the ROM **102**, loads the program to the RAM **103**, and centrally controls the operation of each block of the image forming apparatus **1** shown in FIG. **2** in cooperation with the loaded program.

The image reader **10** includes an automatic document sheet feeding device **11** called an auto document feeder (ADF) and a document image scanning device **12** (scanner).

The automatic document sheet feeding device **11** conveys a document D placed on the document tray with the conveyance mechanism to the document image scanning device **12**. The automatic document sheet feeding device **11** can continuously and ceaselessly read images (on double faces) of a number of sheets of the document D placed on the document tray at once.

The document image scanning device **12** reads the document image by optically scanning the document transferred onto the platen glass from the automatic document sheet feeding device **11** or placed on the platen glass and imaging the reflected light from the document on the receiving face of a CCD (charge coupled device) sensor **12***a*. The image reader **10** generates input image data based on the reading results by the document image scanning device **12**. The input image data is processed by predetermined image processing in the image processor **30**.

The operation/display unit **20** is, for example, a liquid crystal display (LCD) with a touch panel, and functions as a display **21** and an operation interface **22**. The display **21** displays various operation screens, image conditions, and operation states of the functional components according to display control signals input from the controller **100**. The operation interface **22** includes various operation keys such as numeric keys and a start key, and the operation interface **22** receives various input operations by the user and outputs operation signals to the controller **100**.

The image processor **30** includes a circuit that processes image data (input image data) of an input job by digital image processing according to the initial setting or the user setting. For example, the image processor **30** performs gradation correction based on gradation correction data (gradation correction table) under the control of the controller **100**. The image processor **30** processes the input image data by various kinds of correction such as color correction and shading correction and compression processing in addition to gradation correction. The image former **40** is controlled based on the image data processed as described above.

The image former **40** includes image forming units **41**Y, **41**M, **41**C, and **41**K, for forming images of colored toners of components Y, M, C, and K based on the processed image data and an intermediate transfer unit **42**.

The image forming units **41**Y, **41**M, **41**C, and **41**K for components Y, M, C, and K are configured in the same way. For convenience of illustration and description, the parts common to the image forming units **41**Y, **41**C, **41**M, and **41**K are denoted by the same reference numerals. In order to distinguish each of the common components, "Y", "M", "C", or "K" is added to the corresponding reference numeral. In FIG. **1**, only the components of the image forming unit **41**Y for the Y color component have reference numerals, and the reference numerals of the components of the other image forming units **41**M, **41**C, and **41**K are omitted.

Each image forming unit **41** includes an exposure device **411**, a developing device **412**, a photoconductive drum **413** (image carrier), a charging device **414**, and a drum cleaning device **415**.

The photoconductive drum **413** is, for example, a negatively chargeable organic photoconductor (OPC) in which an under coat layer (UCL), a charge generation layer (CGL), and a charge transport layer (CTL) are laminated in order on the peripheral surface of an electroconductive cylindrical aluminum body (aluminum tube). The CGL consists of an organic semiconductor made of a resin binder (e.g. polycarbonate resin) and a charge generation material (e.g. phthalocyanine pigment) dispersed in the resin binder. The CGL generates pairs of positive charges and negative charges when exposed by the exposure device **411**. The CTL consists of a resin binder (e.g. polycarbonate resin) and a hole transport material (electron-donating nitrogen-containing compounds) dispersed in the resin binder. The CTL transfers the positive charges generated at the CGL to the surface of the CTL.

The controller **100** causes the photoconductive drums **413** to rotate at a constant peripheral speed (e.g., 665 mm/s) by regulating driving signals sent to a driving motor(s) (not shown in the drawings) that rotates the photoconductive drums **413**.

The charging device **414** negatively and uniformly charges the surface of the photoconductive drum **413**. The exposure device **411** consists of a semiconductor laser, for example and emits laser light corresponding to images of its color component onto the photoconductive drum **413**. The positive charges generated at the CGL of the photoconductive drum **413** by the exposure are transferred to the surface of the CTL and neutralize the negative charges on the surface of the photoconductive drum **413**. Accordingly, an electrostatic latent image of the corresponding color component is formed on the surface of the photoconductive drum **413** by the electric potential difference between the exposed and non-exposed regions.

The developing device **412** uses a two-component developer that contains toner and carrier. The developing device **412** causes toner of its color component to adhere to the surface of the photoconductive drum **413** to visualize the electrostatic latent image. The developing device **412** thereby forms a toner image.

Hereinafter, the configuration of the developing device **412** is described in detail with reference to FIG. **3**. The developing device **412** forms a toner image on the surface of the photoconductive drum **413** by causing toner of the corresponding color component to adhere to the surface of the photoconductive drum **413**. As shown in FIG. **3**, the developing device **412** includes a first developing roller **412***a*, a second developing roller **412***b*, a collecting roller **412***c***1**, a stirring roller **412***e*, a conveying roller **412***f*, and a sensor **412***g*.

The first developing roller **412***a* and the second developing roller **412***b* each include a rotatable developing sleeve and a developing magnet roll provided inside the developing sleeve. The first developing roller **412***a* and the second developing roller **412***b* are placed close to the photoconductive drum **413** and deliver the developer to their respective developing areas close to the photoconductive drum **413**. More specifically, the first developing roller **412***a* and the second developing roller **412***b* rotate in the same direction, and the upstream first developing roller **412***a* delivers the developer to the downstream second developing roller **412***b* to convey the developer to their respective developing areas. The developing sleeves rotate clockwise in the drawings. The developing magnet roll houses multiple magnetic poles that generate a magnetic field.

The collecting roller **412***c***1** for collecting excess developer is placed close to the second developing roller **412***b*. The collecting roller **412***c***1** is a developer carrier that carries the developer with magnetic force which also includes a rotatable developing sleeve and a developing magnet roll provided inside the developing sleeve.

The toner collected by the collecting roller **412***c***1** is conveyed to the stir-and-convey member **412***c***3** via the guide member **412***c***2**, and then conveyed by the stir-and convey member **412***c***3** to a store room of the stirring roller **412***e* or the conveying roller **412***f*.

The stirring roller **412***e* and the conveying roller **412***f* are spiral-shaped screw members. The stirring roller **412***e* rotates to stir and mix the toner and carrier, so that the toner and carrier are charged by friction. The developer charged by friction is conveyed from the stirring roller **412***e* to the conveying roller **412***f*. The conveying roller **412***f* rotates to convey the charged developer to the developing roller **412***a*. The sensor **412***g* is placed close to the stirring roller **412***e* to detect the toner density. On the basis of the detection result by the sensor **412***g*, a supplying unit (not shown in the drawings) supplies developer according to the amount of the consumed toner.

When the developer arrives at the first developing roller **412***a*, the developer forms magnetic brushes on the outer circumferential surface of the developing sleeve owing to the magnetic field generated by the developing magnet roll of the first developing roller **412***a*. Accordingly, layers of developer are formed on the outer circumferential surface of the developing sleeve. The developing sleeve rotates clockwise in the drawings while holding the developer on its outer circumferential surface with the magnetic field to convey the developer to the developing area, where the developing sleeve is closest to the photoconductive drum **413**. In the developing area, the toner is electrostatically moved to the electrostatic latent image formed on the photoconductive drum **413** from the developing sleeve of the first developing roller **412***a*. On the other hand, part of the developer of the developing sleeve on the first developing roller **412***a* is passed on to the second developing roller **412***b* by the force of the magnetic field. As with the first developing roller **412***a*, the second developing roller **412***b* forms layers of developer on the developing sleeve, and the developer is moved to the photoconductive drum **413** in the developing area.

The developing device **412** thereby supplies toner to the photoconductive drum **413** to make the electrostatic latent image visible with toner. The developing device **412**, which includes the first developing roller **412***a* and the second developing roller **412***b*, can secure developing areas to form high-quality images.

The type of carrier is not specifically limited. A well-known widely used carrier can be used, such as a binder carrier and a coated carrier. The diameter of a carrier particle is preferably 15 to 100 μm, but is not limited thereto.

Similarly, the type of toner is not specifically limited. A well-known widely used toner can be used. For example, a binder resin that contains a colorant and as necessary a charge controlling agent and/or a separating agent and that is treated with an external additive can be used. The diameter of a toner particle is preferably around 3 to 15 μm but is not limited thereto.

The drum cleaner **415** has a drum cleaning blade or the like that slidingly contacts the surface of the photoconductive drum **413**. The drum cleaner **415** removes the residual toner on the surface of the photoconductive drum **413** after the first transfer.

The intermediate transfer unit **42** includes an intermediate transfer belt **421**, first transfer rollers **422** (transfer members), supporting rollers **423**, a second transfer roller **424**, a belt cleaner **426**, and a sensor **427**.

The intermediate transfer belt **421** is an endless belt and is stretched around the supporting rollers **423** to be a loop. At least one of the supporting rollers **423** is a driving roller, and the others are driven rollers. For example, the roller **423**A, which is provided downstream from the first transfer roller **422** for the K-color component in the moving direction of the belt, is preferable as the driving roller. This makes it easy to keep the moving speed of the belt uniform at the first transfer points. Rotation of the driving roller **423**A makes the intermediate transfer belt **421** move at a constant speed in the direction of the arrow A.

The first transfer rollers **422** are provided at the inner circumferential surface side of the intermediate transfer belt **421** so as to face their respective photoconductive drums

413. Each of the first transfer rollers **422** is pressed against the corresponding photoconductive drum **413** with the intermediate transfer belt **421** in between to form a first transfer nip part. At the first transfer nip part, a toner image is transferred from the photoconductive drum **413** to the intermediate transfer belt **421**.

The second transfer roller **424** is provided on the outer circumferential surface side of the intermediate transfer belt **421** so as to face the roller **423**B (hereinafter called backup roller **423**B), which is provided downstream from the driving roller **423**A in the belt moving direction. The second transfer roller **424** is pressed against the backup roller **423**B with the intermediate transfer belt **421** in between to form a second transfer nip part. At the second transfer nip part, a toner image is transferred from the intermediate transfer belt **421** to a sheet of paper.

When the intermediate transfer belt **421** passes through the first transfer nip parts, the toner images formed on the surfaces of the photoconductive drums **413** are sequentially transferred onto the intermediate transfer belt **421** so as to be superposed on top of one another (first transfer). More specifically, a first transfer bias is applied to each first transfer roller **422**, so that charges having reverse polarity to that of the toner are given to the inner surface side of the intermediate transfer belt **421** (the side abutting the first transfer rollers **422**). Accordingly, the toner images are electrostatically transferred onto the intermediate transfer belt **421**.

Thereafter, when the sheet passes through the second transfer nip part, the toner image on the intermediate transfer belt **421** is transferred onto the sheet (second transfer). More specifically, a second transfer bias is applied to the second transfer roller **424**, so that charges having reverse polarity to that of the toner are given to the inner surface side of the sheet (the side abutting the second transfer roller **424**). Accordingly, the toner image is electrostatically transferred onto the sheet. The sheet on which the toner image is transferred is then conveyed to the fixer **60**.

The belt cleaner **426** includes a belt cleaning blade **426** that slidingly contacts the surface of the intermediate transfer belt **421** and removes the toner remaining on the surface of the intermediate transfer belt **421** after the second transfer. Instead of the second transfer roller **424**, a belt-type second transfer unit may be used. The belt-type second transfer unit has a second transfer belt stretched around supporting rollers including a second transfer roller to be a loop.

The sensor **427** is placed between the roller **423**A and the roller **423**B so as to face the surface of the intermediate transfer belt **421**, for example. The sensor **427** detects the amount of toner adhering to the intermediate transfer belt **421**. The sensor **427** is, for example, an optical reflection density sensor and is usable for controlling the image density.

The fixer **60** heats and pressurizes, at a fixing nip part, the conveyed sheet on which the toner image has been transferred by the second transfer to fix the toner image to the sheet.

The sheet conveyer **50** includes a sheet feeder **51**, a sheet ejector **52**, and a conveyance path unit **53**. The sheet feeder **51** has three sheet feeding tray units **51***a*, **51***b*, and **51***c* that house sheets of paper (standardized paper and/or special paper) by predetermined types, the sheets being sorted according to the basis weight and/or the size. The conveyance path unit **53** has pairs of conveying rollers, such as a pair of register rollers **53***a*.

The sheets housed in the sheet feeding tray units **51***a* to **51***c* are sent out one by one from the top and conveyed to the image former **40** by the conveyance path unit **53**. A register roller unit having the pair of register rollers **53***a* registers the fed sheet and adjusts timing of conveying the sheet. The image former **40** transfers the toner image on the intermediate transfer belt **421** onto one side of the sheet as the second transfer. The fixer **60** then performs fixing on the sheet. The sheet on which the image has been formed is ejected outside the apparatus by the sheet ejector **52** that has sheet ejecting rollers **52***a*.

The sheets may be long paper or rolled paper. The sheet of long paper/rolled paper is stored in a sheet feeding device (not shown in the drawings) connected to the image forming apparatus **1**. The sheet is supplied to the image forming apparatus **1** from the sheet feeding device through the sheet feeding opening **54** and then sent out to the conveyance path unit **53**.

The storage **70** consists of, for example, a nonvolatile semiconductor memory (flash memory) and/or a hard disc drive. The storage **70** stores various kinds of data including information on various settings of the image forming apparatus **1**.

The communication unit **80** consists of a communication control card, such as a local area network (LAN) card, and exchanges data with external devices (e.g. personal computer) connected to communication networks, such as a LAN and a wide area network (WAN).

[Suction Cleaning of Scattered Toner]

Next, a technique of suction cleaning of scattered toner produced at the developing device is described.

The image forming apparatus **1** includes a fume prevention plate **90** (Y, M, C, K), a suction duct **91** (Y, M, C, K), and a closing valve **93** (Y, M, C, K) in each developing device **412**, and an air suction device **92** (FIG. **4**) as shown in FIG. **3** or **4**.

The fume prevention plate **90** covers part of an internal space **94** of the developing device **412** where the developing roller **412** *a, b* are placed and the developer is stored so as to prevent the toner from scattering outside of the internal space **94**.

The fume prevention plate **90** covers the upper part of the internal space **94**, and a suction opening **91***a* of the suction duct **91** is provided above the developing roller **412***b*. The suction opening **91***a* of the suction duct **91** is provided adjacent to the end of the fume prevention plate **90** near the developing roller **412***b*. Part of the end of the fume prevention plate **90** near the developing roller **412***b* is a movable portion **90***a* as shown in FIGS. **5** and **6**.

The suction opening **91***a*, which is an end of the suction duct **91** is connected to the internal space **94** as described above.

The other end of the suction duct **91** is connected to the air suction device **92**, merging into the other suction ducts **91** of colors, as shown in FIG. **4**. The closing valves **93** (Y, M, C, K) are provided for the respective suction ducts **91** (Y, M, C, K) of colors before the merge, as shown in FIG. **4**.

The movable portion **90***a* can change its position between the first position shown in FIG. **5** and the second position shown in FIG. **6** different from the first position, and the controller **100** regulates the position of the movable portion **90***a* to the first position (FIG. **5**) and the second position (FIG. **6**). The movable support mechanism of the movable portion **90***a* is realized in this embodiment as the end of the movable portion **90***a* on the suction direction side is movably supported by a hinge fulcrum, but is not particularly limited thereto.

The developer scattered at the time of development can be sucked and removed by suction through the suction opening

91*a* via the suction duct **91** when the movable portion **90***a* is at the first position as shown in FIG. **5**. The controller **100** performs the image forming operation only when the movable portion **90***a* is at the first position as shown in FIG. **5**, and operates the air suction device **92** to perform suction removal of the scattered developer.

On the other hand, the controller **100** controls the suction mode of sucking the internal space **94** via the suction duct **91** with the air suction device **92** except at the time of image formation.

The controller **100** moves the movable portion **90***a* from the first position to the second position in the suction mode (during suction). The device for moving the movable portion **90***a* may consist of a solenoid **96***a* and a link mechanism **96***b* as shown in FIG. **7**, for example, but is not limited thereto.

The movable portion **90***a* is not moved at the time of image formation and fixed to the first position. This prevents toner spill that influences an image.

The controller **100** moves the movable portion **90***a* in the suction mode. When the movable portion **90***a* is moved to the second position (from FIG. **5** to FIG. **6**), part of the developer accumulated on the movable portion **90***a* may fall inside the suction duct **91**. The developer falling from the movable portion **90***a* is removed by suction because it is in the suction mode.

As shown in FIG. **5**, the movable portion **90***a* is disposed along the collecting roller **412***c***1** (developer carrier) at the first position. When the movable portion is at the first position, the suction path of the suction duct **91** is provided on the opposite side of the collecting roller **412***c***1** with the movable portion **90***a* of the fume prevention plate **90** in between.

The movable portion **90***a* is more separate from the collecting roller **412***c***1** at the second position of FIG. **6** than at the first position of FIG. **5**. Being separated from the collecting roller **412***c***1** at the second position, the movable portion **90***a* is less influenced by the magnetic force from the collecting roller **412***c*. Thus, the developer easily falls from the movable portion **90***a*.

The upper face of the movable portion **90***a* at the first position on which the developer is likely to be accumulated forms the lower face of the suction duct **91**, and the upper face of the movable portion **90***a* at the second position is inclined downward in the suction direction. The developer then falls from the movable portion **90***a* into the suction duct **91** on the suction direction side further from the movable portion **90***a*.

In summary, the developer accumulated on the movable portion **90***a* is sucked toward the air suction device **92** and removed effectively and effectively by the reaction when the movable portion **90***a* is moved from the first position to the second position, the reduction of magnetic force acting from the collecting roller **412***c***1**, the gravity that causes the developer to fall along the downward inclination, and the suction force.

In order that the developer falls from the movable portion **90***a* into the suction duct **91**, the following operations may be performed under the control of the controller **100**.

One way is to move the movable portion **90***a* to and fro in the suction mode. The controller **100** moves the movable portion **90***a* from the second position toward the first position and then back to the second position (to and fro) one time or multiple times in the suction mode. This increases the possibility that the developer that has not fallen in the first movement fall from the movable portion **90***a*.

It is preferable that each of the developing devices **412** undergoes the suction mode individually. The suction force of the air suction device **92** is concentrated on one of the developing devices **412**, realizing efficient suction.

When the developing device **412**Y undergoes the suction mode, the controller **100** causes the air suction device **92** to perform the suction while the closing valve **93**Y is open as shown in FIG. **4** and the closing valves **93**M, **93**C, and **93**K are closed, and the controller **100** controls the operation of the movable portion **90***a* of the fume prevention plate **90**Y and the operation of the vibrating device **95**Y. The other developing device **412**M, **412**C, or **412**K undergoes the suction mode while the suction path to the concerning developing device is opened and the other paths are closed by the open/close control of the closing valves **93** (Y, M, C, K).

(Second Suction Path)

In the above example, regardless of whether the movable portion **90***a* is at the first position or the second position, the suction path of the suction duct **91** is between the fume prevention plate **90** and the upper face member **91***b*. When the movable portion **90***a* is at the second position, air is blown from the space between the end of the movable portion **90***a* and the upper face member **91***b*.

Here, when the movable portion **90***a* is at the first position, the suction path of the suction duct **91** is the first suction path, and when the movable portion **90***a* is at the second position, the suction path of the suction duct **91** is the second suction path.

The first suction path and the second suction path may be different from each other. The first suction path is designed focusing on suction of fumes of the developer from the internal space **94**, and the second suction path is designed focusing on removal of the developer accumulated inside the suction duct **91**.

For one thing, the movable portion **90***a* includes air vent holes **90***h* as shown in FIGS. **8** to **10**, and the first suction path is not different from the above example as shown in FIG. **8**, but the second suction path is a path passing through the air vent holes **90***h* as shown in FIGS. **9** and **10**.

The air vent holes **90***h* are dotted on the movable portion **90***a*. This makes it easier for the airflow to work on each part of the movable portion **90***a* during suction. It is thus easier to suck and remove the developer by ripping off from the movable portion **90***a*. As the air vent holes **90***h* are provided on the movable portion **90***a*, the space produced between the end of the movable portion **90***a* and the upper face member **91***b* when the movable portion **90***a* is at the second position may be closed so that ventilation is impossible, or may be left for ventilation during suction.

In order to provide the vent holes **90***h* on the movable portion **90***a*, the movable portion **90***a* may have a mesh structure **90***m* with the air vent holes **90***h* as shown in FIG. **11**.

Check valves **90***v* that prevent backflow against the ventilation direction in the suction mode may be provided on the air vent holes **90***h*, as shown in FIG. **12**. This can prevent the developer from flowing back through the air vent holes **90***h* and falling into the internal space **94** again.

The fume prevention plate **90** may include a fixed portion **90***b* that closes the air vent holes **90***h* when the movable portion **90***a* is at the first position, as shown in FIG. **13**. This can limit the suction to that through the suction inlet **91***a* above the developing rollers **412***a, b* and omit the air vent holes **90***h* from the suction path when the movable portion **90***a* is at the first position.

When the movable portion **90***a* is at the second position as shown in FIG. **14**, the air vent holes **90***h* are separate from the fixed portion **90***b*, enabling ventilation.

The fixed portion **90***b* may coexist with the check valves **90***v*.

An auxiliary movable portion **91***c* that is raised toward the center of the suction duct **91** may be provided on the suction duct as shown in FIG. **14**, and thereby making the cross-sectional area of the flow path of the movable portion **90***a* changeable.

In that case, the controller **100** reduces the cross-sectional area of the flow path of the above-described downstream part by the auxiliary movable portion **91***c* extended when the movable portion **90***a* is at the second position (FIG. **14**) in comparison to when the movable portion **90***a* is at the first position (FIG. **13**), increasing the suction force placed by the air suction device **92** on the movable portion **90***a*. This makes it possible to suck and remove the developer accumulated on the movable portion **90***a* efficiently and effectively.

The restricting mechanism that can change the cross-sectional area of the flow path is not limited to the illustrated example, and a flexible portion may be provided to restrict the area, for example. However, preferably, the upper part of the area of the flow path of the suction duct **91** is restricted and the lower part is not restricted as shown in FIG. **14**. That is because the developer falling from the movable portion **90***a* easily flows toward the air suction device **92**.

The movable portion may consist of a first movable portion **90***a***1** and a second movable portion **90***a***2** as shown in FIG. **15**, and the first movable portion **90***a***1** and the second movable portion **90***a***2** may overlap each other when they are at the first position.

The first movable portion **90***a***1** and the second movable portion **90***a***2** have each air vent holes.

The second suction path passes through air vent hols **90***h***1** of the first movable portion **90***a* and air vent holes **90***h***2** of the movable portion **90***a***2** as shown in FIG. **16**.

When the first movable portion **90***a***1** and the second movable portion **90***a***2** are at the first position as shown in FIG. **15**, the air vent holes **90***h***1** of the first movable portion **90***a***1** are covered by the structure around the air vent holes **90***h***2** of the second movable portion **90***a***2**, and the air vent holes **90***h***2** of the second movable portion **90***a***2** are covered by the structure around the air vent holes **90***h***1** of the first movable portion **90***a***1**. That is, the air vent holes **90***h***1** and the air vent holes **90***h***2** do not communicate with each other. This makes it possible to limit the suction to that through the suction inlet **90***a* above the developing rollers **412***a, b* by closing the suction path through the movable portions **90***a***1**, **90***a***2** when the movable portions **90***a***1**, **90***a***2** are at the first position.

Specifically, the hinge fulcrum of the second movable portion **90***b* is separate from the hinge fulcrum of the first movable portion **90***a***1** in the suction direction, but the structure is not limited to this.

(Control Flow Example)

Next, an example of the control flow from the print mode to the suction mode by the controller **100** is described with reference to the flowchart of FIG. **17**.

If the controller **100** detects a print end signal in a print mode R**10** where the image formation is performed (S**11**), the controller **100** turns off the development motor and stops an action of the developing device **412** (S**12**).

Next, the controller **100** operates the air suction device **92** and proceeds to a suction mode R**20**. If the air suction device **92** is already in operation, the air suction device **92** continues to be in operation. In the case where the suction output in the print mode R**10** is different from that in the suction mode R**20**, the controller **100** specifies the suction output of the air suction device **92** to that in the suction mode R**20**. Especially, the suction output in the suction mode R**20** is preferably high.

Here, as described above, each of the developing devices **412** that needs to be cleaned by the suction mode individually undergoes the suction mode. For example, if it is determined that the developing devices **412**Y, **412**M, and **412**C need to undergo the suction mode at some timing, each of the developing devices **412**Y, **412**M, and **412**C individually undergoes the suction mode one by one.

After proceeding to the suction mode R**20**, the controller **100** moves the movable portion **90***a* of the fume prevention plate **90** to the second position (S**21**).

After moving the movable portion **90***a* to the second position, the controller **100** starts vibration application by the above-described vibrating device **95** (S**22**).

After a predetermined time elapsed, the controller **100** moves the movable portion **90** of the fume prevention plate **90** to the first position (S**23**), ends the vibration application with the vibrating device **95** (S**24**), stops the air suction device **92** (S**25**), ends the suction mode R**20**, and then proceeds to the standby state. When the suction mode R**20** is ended, the closing valves **93**Y, **93**M, and **93**K are all opened for the suction in the print mode R**10**.

If an unprocessed print job has been already input, the process proceeds to the print mode R**10**. In that case, the closing valves **93**Y, **93**M, **93**C, and **93**K are all opened, and the air suction device **92** continues to be in operation (In the case where the suction output in the print mode R**10** is different from that in the suction mode R**20**, the controller **100** specifies the suction output of the air suction device **92** to that in the print mode R**10**).

If a new print job is input after ending the suction mode R**20** and proceeding to the standby state, the controller **100** operates the air suction device **92** for the suction in the print mode R**10**.

As described hereinbefore, in this embodiment, the developer scattering inside the developing device **412** by the development operation can be sucked and removed, and the developer accumulated on the fume prevention plate **90** can be removed efficiently and effectively. This makes it possible to keep the image quality good.

The scope of the present invention is not limited to the above-described embodiment, and includes various modifications within the scope of the claims of the present invention.

In the above-described embodiment, the position of the movable portion **90***a* is controlled by the controller, but may be changed only manually. It is possible that a service person uses the mechanism to change the position in maintenance.

What is claimed is:

1. An image forming apparatus comprising:

an image carrier;

an exposure device that forms an electrostatic latent image on the image carrier;

a developing device that supplies, using a developing roller facing the image carrier, a developer to the electrostatic latent image formed on the image carrier to form a toner image; and

a hardware processor that controls the image carrier, the exposure device, and the developing device,

wherein the image forming apparatus further includes:

a fume prevention plate that covers a part of an internal space of the developing device where the developing roller is disposed and the developer is stored and that prevents the developer from scattering outside from the internal space;

a suction duct; and

an air suction device,

wherein an inlet end of the suction duct is positioned adjacent to the internal space and an outlet end of the suction duct is in communication with the air suction device,

wherein the fume prevention plate includes a movable portion positioned at the inlet end of the suction duct and extending into the internal space,

wherein a position of the movable portion can be changed between a first position and a second position different from the first position.

2. The image forming apparatus according to claim **1**,

wherein the hardware processor controls the position of the movable portion such that the movable portion is at the first position or the second position.

3. The image forming apparatus according to claim **2**,

wherein the hardware processor controls image formation and controls a suction mode to suck the internal space through the suction duct by the air suction device except at a time of the image formation,

wherein the hardware processor executes the image formation only when the movable portion is at the first position, and moves the movable portion to the second position during the suction mode.

4. The image forming apparatus according to claim **3**,

wherein the hardware processor moves the movable portion only during the suction mode.

5. The image forming apparatus according to claim **3**,

wherein the hardware processor moves the movable portion from the second position toward the first position and then toward the second position back again one time or multiple times during the suction mode.

6. The image forming apparatus according to claim **3**,

wherein the hardware processor stops the air suction device at an end of the suction mode.

7. The image forming apparatus according to claim **3**,

wherein the developing device includes multiple developing devices,

wherein the hardware processor executes the suction mode individually for each of the multiple developing devices.

8. The image forming apparatus according to claim **3**, further comprising:

a vibrating device that applies vibration to the developing device,

wherein the hardware processor causes the vibrating device to apply vibration to the developing device during the suction mode.

9. The image forming apparatus according to claim **3**,

wherein a first suction path of the suction duct that is open when the movable portion is at the first position is different from a second suction path of the suction duct that is open when the movable portion is at the second position.

10. The image forming apparatus according to claim **9**,

wherein the movable portion includes an air vent hole,

wherein the second suction path is through the air vent hole.

11. The image forming apparatus according to claim **10**,

wherein the movable portion includes a mesh structure with the air vent hole.

12. The image forming apparatus according to claim **10**,

wherein a check valve that prevents backflow against a ventilation direction during the suction mode is provided on the air vent hole.

13. The image forming apparatus according to claim **10**,

wherein the fume prevention plate includes a fixing portion that closes the air vent hole when the movable portion is at the first position,

wherein the air vent hole is separate from the fixing portion for ventilation when the movable portion is at the second position.

14. The image forming apparatus according to claim **10**,

wherein the movable portion includes a first movable portion and a second movable portion,

wherein the first movable portion and the second movable portion overlap with each other when the movable portion is at the first position.

15. The image forming apparatus according to claim **14**,

wherein each of the first movable portion and the second movable portion includes the air vent hole,

wherein the second suction path is through the air vent hole of the first movable portion and the air vent hole of the second movable portion,

wherein when the first movable portion and the second movable portion are at the first position, the air vent hole of the first movable portion is covered by a peripheral structure of the air vent hole of the second movable portion, and the air vent hole of the second movable portion is covered by a peripheral structure of the air vent hole of the first movable portion.

16. The image forming apparatus according to claim **1**,

wherein a cross-sectional area of a flow path of the suction duct on a downstream side with respect to the movable portion is changeable,

wherein the hardware processor reduces the cross-sectional area of the flow path of the suction duct on the downstream side when the movable portion is at the second position in comparison to when the movable portion is at the first position, increasing a suction force placed on the movable portion by the air suction device.

17. The image forming apparatus according to claim **1**, further comprising:

a developer carrier that carries the developer by a magnetic force and that is disposed in the internal space,

wherein the movable portion is disposed along the developer carrier when the movable portion is at the first position.

18. The image forming apparatus according to claim **17**,

wherein a suction path of the suction duct is on an opposite side of the developer carrier with the fume prevention plate in between when the movable portion is at the first position.

19. The image forming apparatus according to claim **17**,

wherein the movable portion is more separate from the developer carrier when the movable portion is at the second position than when the movable portion is at the first position.

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